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WA98 Comments on its Future Plans to the Cogne Meeting of the SPSLC in 1995

WA98 Collaboration

This report is submitted to support the discussions of the SPSLC on the future of the Heavy Ion program at the SPSLC meeting at Cogne.

Summary

After the experience with the first lead beam in November last year, the experiment WA98 will have minor upgrades before the lead run in fall of 1995. In 1996 a second tracking arm will largely increase the discovery potential in the hadronic probes. Due to the need for high accuracy photon data the experiment requires both running periods in 1995 and 1996 to obtain sufficient statistics. The collaboration requests to postpone the closure of the I3 beam in the West Area and requests one additional lead run at 30-40 AGeV in 1997. In addition, the collaboration requests a period of 2 weeks with 160-180 GeV/c protons running in the SPS. This would enable a dedicated proton experiment providing the collection of photon data up to large transverse momenta in the hard scattering regime, which are mandatory for a proper comparison to the ion data.

Physics Goals of WA98:

The goals of the experiment WA98 are as follows:

via hadronic signals:

- to measure the nuclear stopping power, the baryon content at mid-rapidity, and the reaction mechanism by detecting protons over a large region of rapidity
- to study the degree of thermalisation and of chemical equilibrium by comparing the ratio of cross sections and the momentum distributions of well identified mesons and baryons
- to measure source sizes via two-particle correlations as function of the transverse mass of the pair
- to determine the charged particle multiplicity density distribution and possible fluctuations

via electromagnetic signals:

- to carry out high precision measurements of the production of neutral mesons
- to search for a photon enrichment in each event or in an event class by measuring the photon multiplicity in the forward hemisphere compared with the charged particle multiplicity.
- to determine with high precision the thermal photon production from a Hadronic Plasma and from a Quark Gluon Plasma

In addition, the events will be characterized globally by the number of participants and thus their impact parameter via measurements of the forward energy flow measurement as well as the energy flow in the target rapidity region, by the energy density via measurements of the electromagnetic and hadronic energy flow, and by the entropy density via the charged particle multiplicity and the particle density as function of rapidity.

Recently, the physics discussion related to the spectacular "Centauro" and "anti-Centauro" events in cosmic ray data has been revived. Bjorken relates these observations to a Disoriented Chiral Condensate (DCC) which should manifest itself in large fluctuations of the ratio of neutral to charged pions at low transverse momentum. At the same time, coherent emission of low p_t pions is expected. Our experiment is extremely well suited to search for such exotic phenomena: The charged hadron spectrometer measures momenta down to p_t=0 and the measurement of the ratio of neutral to charged particles (N_γ/N_{charge}) provides the sensitivity to identify abnormal ratios on an event by event basis. In such selected events the Bose-Einstein correlations of charged pions should disappear due to the increased coherence of the pion emitting source.

Shuryak et al. investigated recently the energy dependence theoretically. For the region around 30 AGeV the longest lifetime of the fireball is predicted while the expansion flow appears to be strongly reduced as compared to 200 AGeV. Our experimental setup measuring the temperature of the hot matter system by the photon spectrum and determining the thermal and geometrical characteristics of the hadron source by multidimensional Bose-Einstein studies, is perfectly suited for low energy running to sense such an important variation in the properties of the created fireball.

1) Status:

The WA98 experiment took data in 1994 according to its physics program with most detectors in place and working. However, due to the many innovative electronics items and the critical spill structure of the beam, the 1994 run must be considered only partially as a data taking run and partially as a technical run to get the various new developments well understood.

Specifically, the following problems are curently being solved for the 1995 running:

a) the Data Acquisition System encountered a huge data flow which needs upgrading of the system at many levels in order to allow the collection of the high statistics data.

b) the Silicon Drift Detector (of the same type as in NA45, however employing a new and very thin mounting structure to comply with the photon detectors) needs improvements to provide on-line calibration and stable running conditions. A second detector will be installed in order to measure the charged particle multiplicity as outlined in the proposal in a wide range of rapidity and fully overlapping the PMD.

c) the combination of the MSAC tracking system with the Silicon Detectors needs investigation in order to properly shield the RF noise from the feedback of the MSAC gate signals.

d) during the December run an increase in the noise of the new lead glass electronics has been observed which requests investigation and must be avoided in order to fully exploit the good resolution of the photon spectrometer.

e) Radiation alarm limited the beam intensity to half the design value. Additional shielding has been put into place to go to the 2×10^6 lead ions per spill.

f) The micro structure of about 5 μs in the beam and other instabilities in the spill have to be reduced in order to raise the effective spill time from 1.5 s to 4 s enabling only then to take high statistics data within a reasonable time.

2) Plans for 1995

We are presently working on solving all the above mentioned problems. In addition, we are building the proposed Charged Particle Veto detector which is based on streamertubes equipped with newly developed readout electronics containing both analog and digital functions in the same chip. This detector will be installed in summer into the set up, tested in a hadron beam late summer and fully operational for the 1995 lead run.

The charged particle multiplicity detector will be improved. We are planning to refurbish the existing 3" Silicon Drift Detectors. We also hope to profit from a joint effort with NA45 and BNL to produce a new 4" Silicon Drift Detector and associated electronics. The decision of which SDD detector will be installed will be taken later during the year but well before the lead run.

The high resolution Silicon Drift Detectors will be supplemented by a Silicon Pad Detector installed by our MIT group. This detector combination provides an improved sensitivity to the delta-electron contamination and will allow to trigger on high particle multiplicities as well as veto on interactions downstream of the target affecting dominantly peripheral events.

Besides the hadron beam commissioning running in summer and early fall we will be ready to take data at an increased speed in November 1995.

3) Plans for 1996

a) Upgrade of the experimental set-up

Going back to our early ideas of a lead beam experiment with two hadronic tracker arms we are debating presently to achieve this goal with the help of the Japanese group of Dr. Miake (Tsukuba University) who is joining our collaboration. Being world experts on Time of Flight measurements they will bring their 1000 module TOF system foreseen for the PHENIX Detector at RHIC with a time resolution of ~ 70 ps. The tracking chambers of the second arm will be of MSAC typ equipped with pad readout. The readout electronics are newly developed and contains in an ASIC both analog and digital functions. The chips will be mounted in "CHIP-ON-BOARD" technique which means that the chips are glued to the thin PC-board containing the padstructure on the opposite side. The connections between the board and the chips are made by ultrasound bonding. This mounting technique is very attractive since it can be made very thin thus avoiding secondary interactions in the mounting material.

The upgrade will allow us to measure simultaneously in one event-group selection the Bose-Einstein correlation of particles and their anti-particles, as well as resonances like the ϕ via the K^+K^- channel.(see figure on the acceptance in the proposed two arm set-up). The full two-arm setup is to be installed and ready for data tacking on March 31st, 1996.

b) Proton Running

Running conditions with 160 GeV/c protons are very bad compared with those of a primary heavy ion beam, especially in view of the need for high statistics data up to large p_t. A special low energy run of the SPS at ~ 160 to 180 GeV/c and a long spill of up to 8 s would make such reference data of high quality possible. A serious look into such a special run is requested.

Due to the specific features of the West Area beam line system and the experimental conditions at the OMEGA magnet, WA98 cannot get the proton reference data ahead of the lead beam running. If no special proton run can be arranged as requested above, then we request to run secondary proton beams in early spring of 1996.

In fall of 1996 we expect to finish the data taking at 160 AGeV with a sample of 20 million good central events and 20 million good peripheral events.

4) Plans for 1997

As outlined in our proposal we planned for running at two other energies below 160 AGeV. The new theoretical work by Shuryak on 'the longest lived fireball' mentioned earlier gives us further motivation. The acceptance for low energy running and the functioning of our detectors at low energy is well studied and poses absolutely no problem. We therefore request one additional lead running period at 30-40 AGeV in 1997.

From the experience with the 60 AGeV Oxygen running we conclude that with the increased flat top and the increased spill length of up to 8 s at the lower lead energy we can obtain all the needed high statistics data (20 million central and 20 million peripheral events) in about one beam time of 6 weeks.

5) Plans for the Decommissioning of WA98 at the End of 1997

A memorandum of understanding has been signed with the PHENIX Collaboration stating the move of the lead glass spectrometer to PHENIX at RHIC at BNL not later than 6 months before start up of operation of RHIC which is scheduled to take place spring 1999. The PMD is proposed to go to the detector STAR. Both detectors are not compatible with the plans of the ALICE Detector at the LHC. Most of the WA98 teams involved in the lead glass and in the PMD are committed to build new detectors for the ALICE experiment.

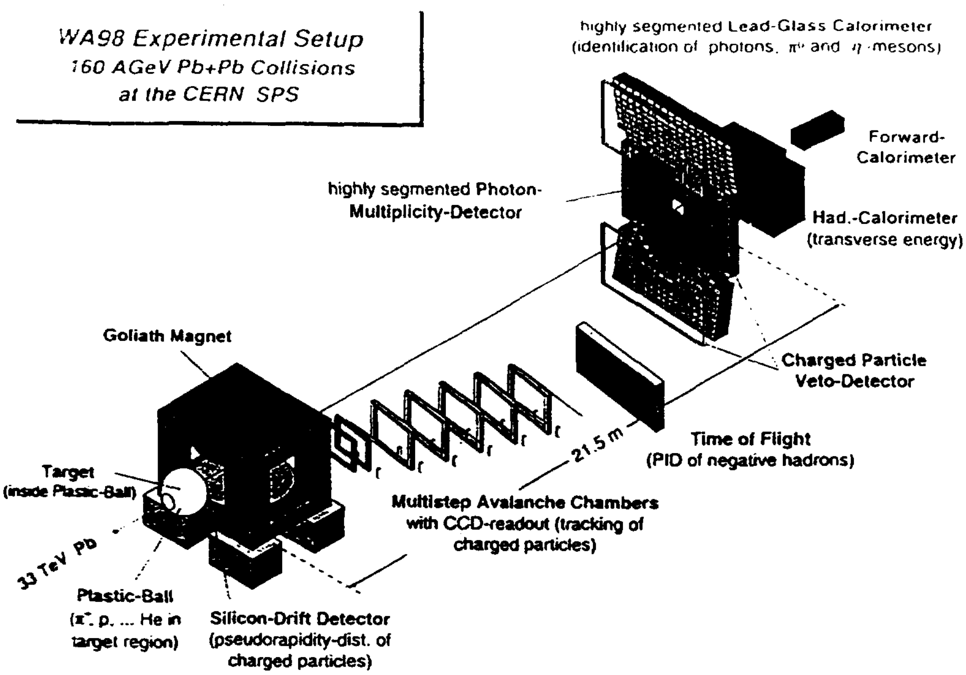

Fig. 1 WA98 experimental set-up in 1995 and the new Charged Particle Veto Detector

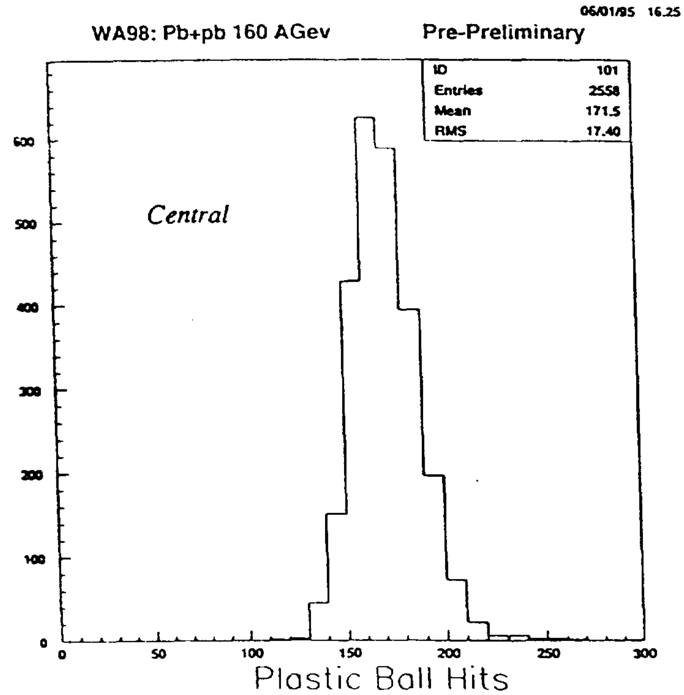

Fig. 2 Multiplicity in Plastic Ball for central 160 AGeV Pb+Pb collisions

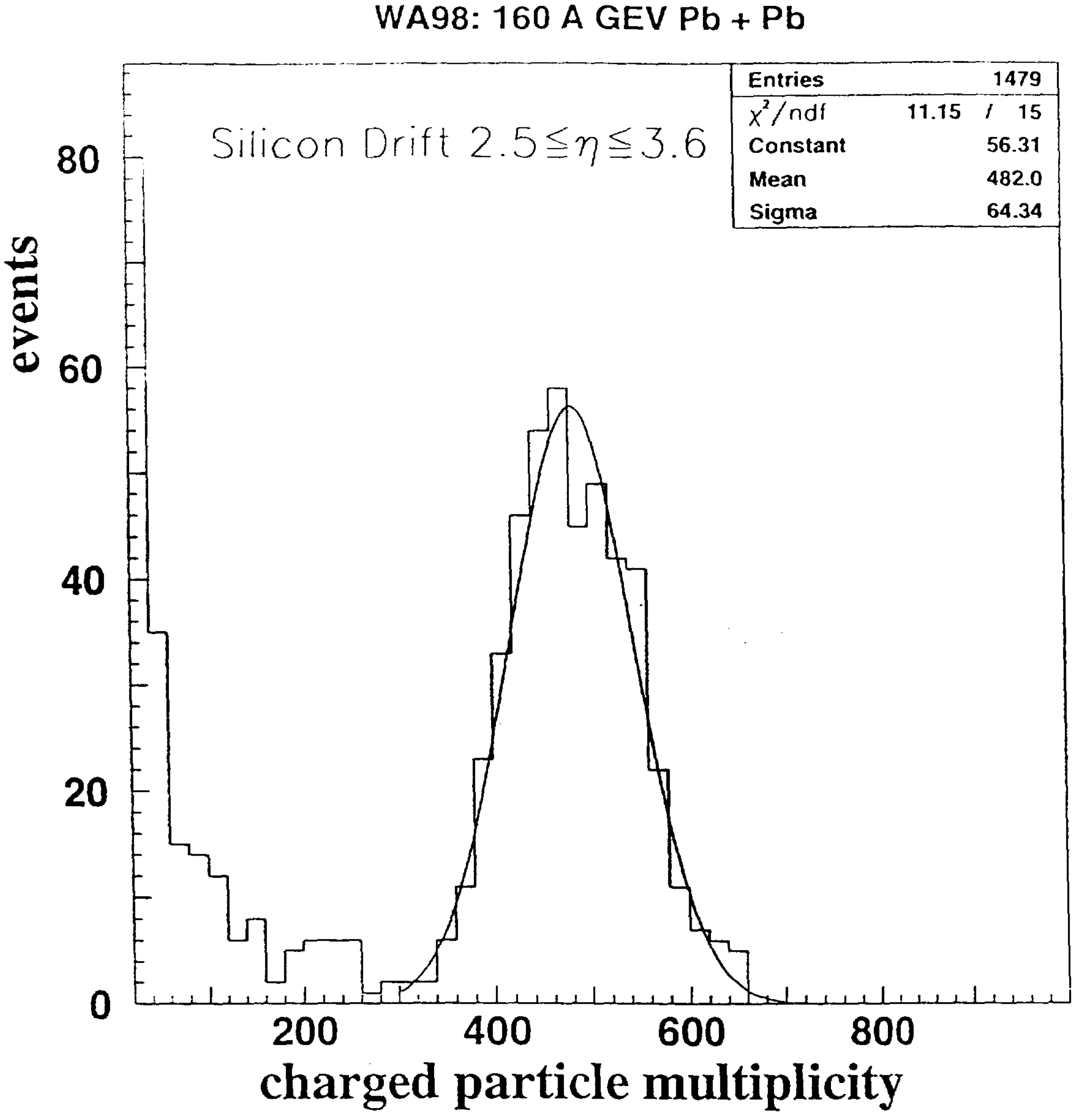

Fig. 3 Multiplicity of charged particles measured in the Silicon Detector for central 160 AGeV Pb+Pb collisions

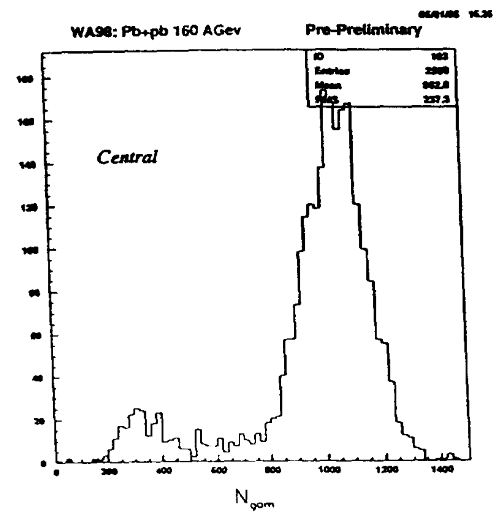

Fig. 4 Multiplicity of photonlike clusters in the PMD

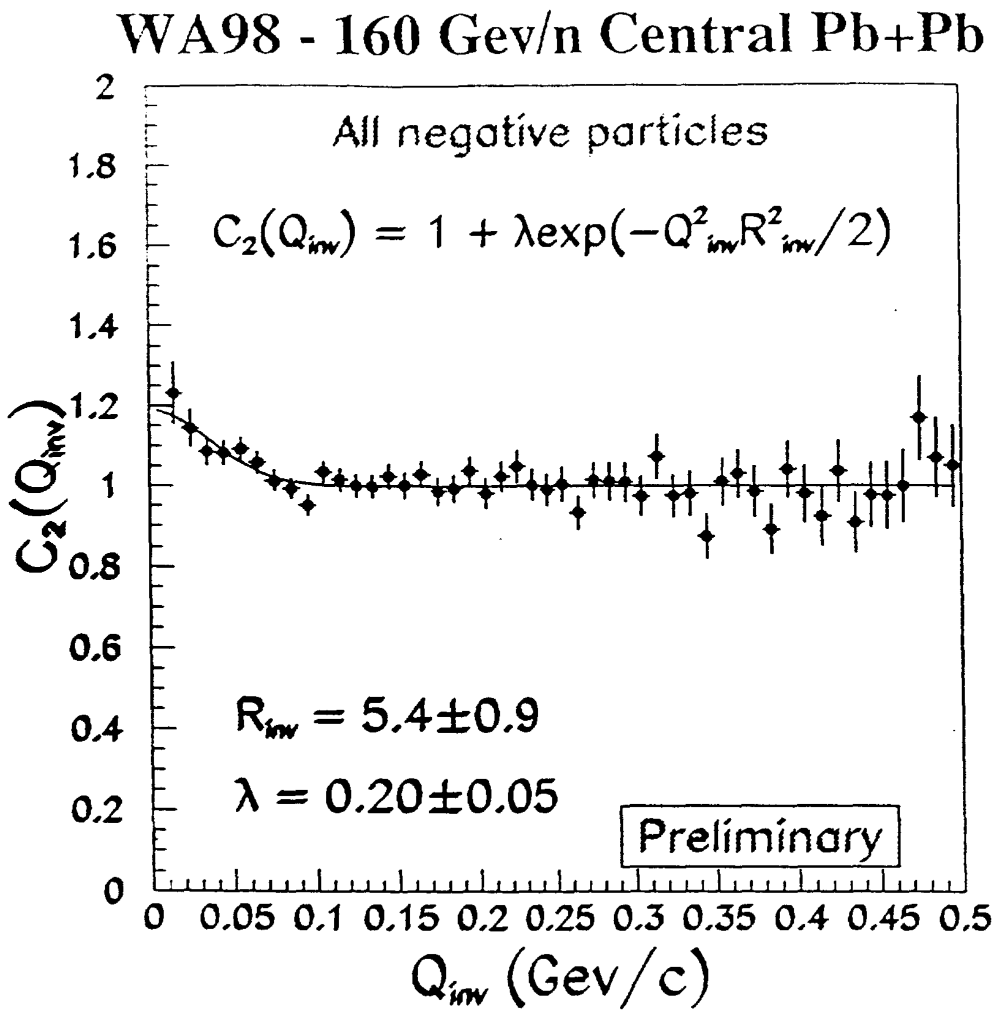

Fig. 5 Bose-Einstein correlations (HBT) from the Hadronic Tracker for central Pb+Pb collisions

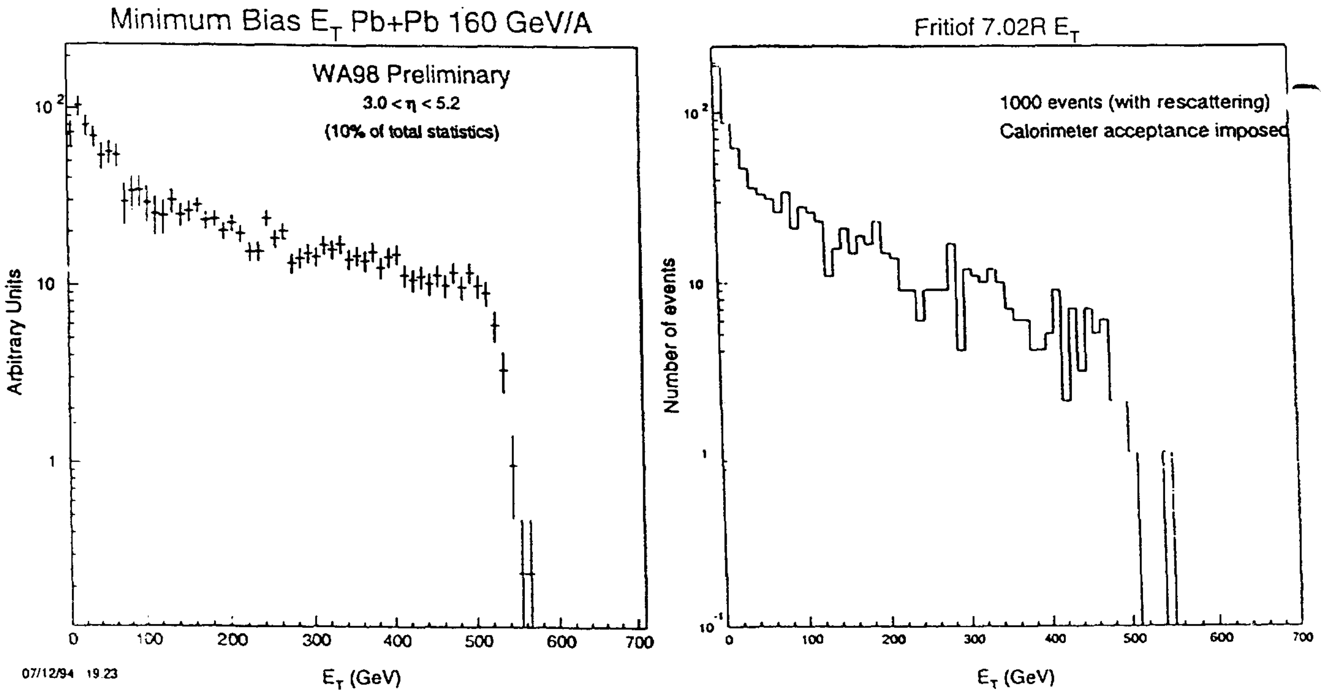

Fig. 6 E_t from the Mid Rapidity Calorimeter for central Pb+Pb collisions

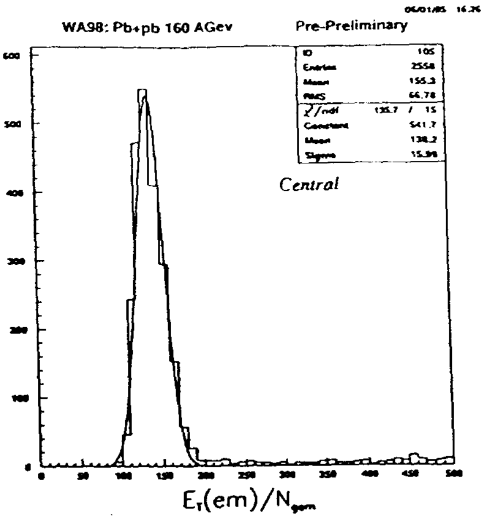

Fig. 7 Electromagnetic-E_t/photon for central Pb+Pb collisions

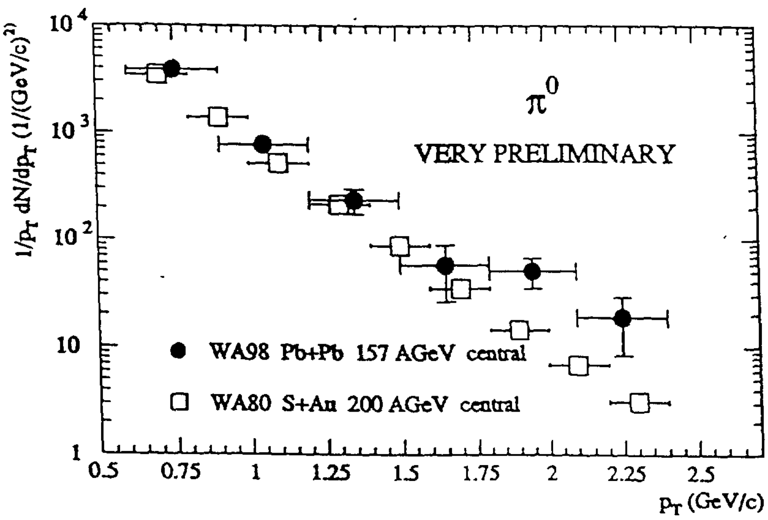

Fig. 8 π^0 Transverse Momentum Spectrum in Lead Glass Spectrometer for central Pb+Pb collisions

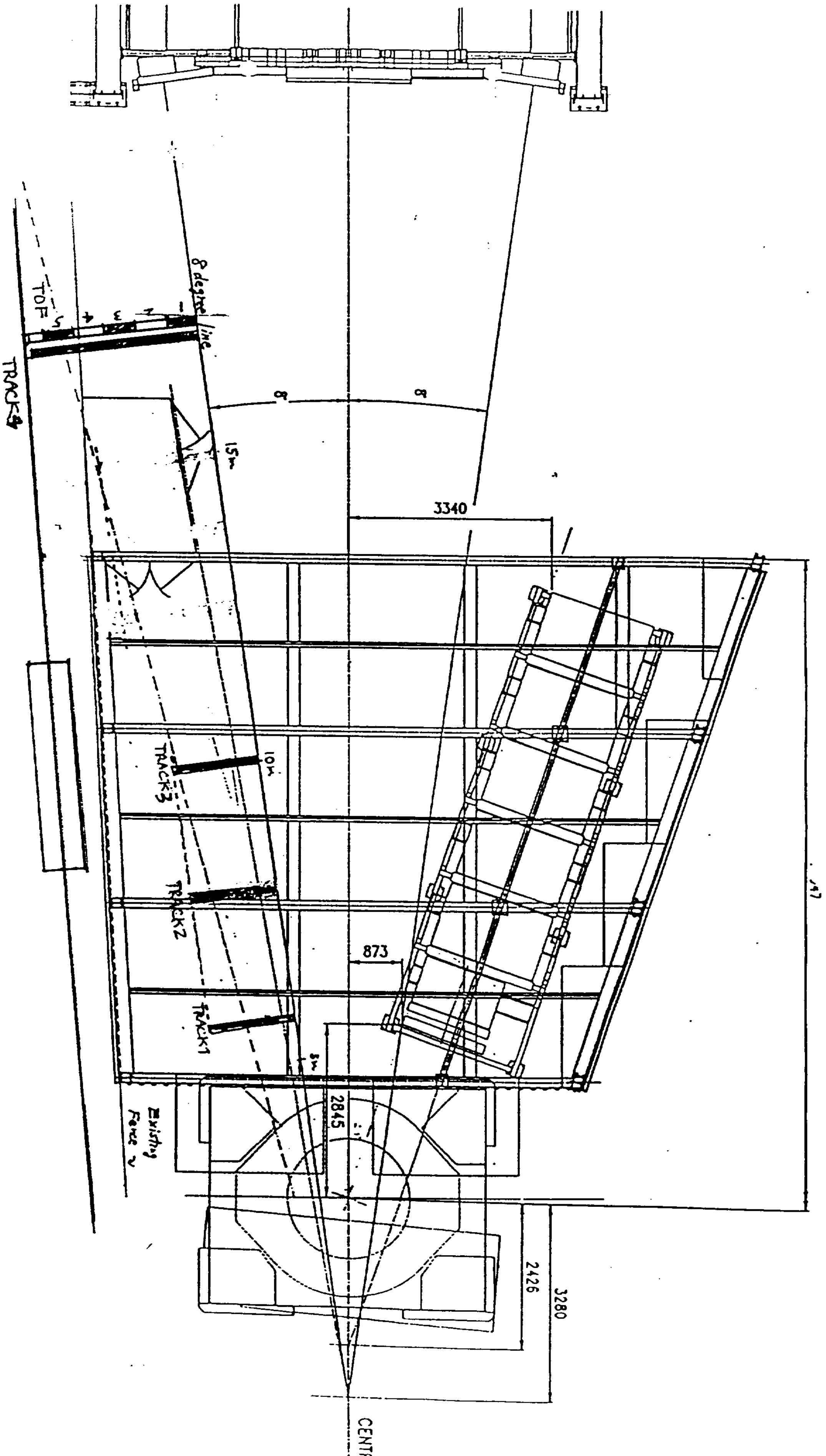

Fig. 9 New two arm set -up for 1996

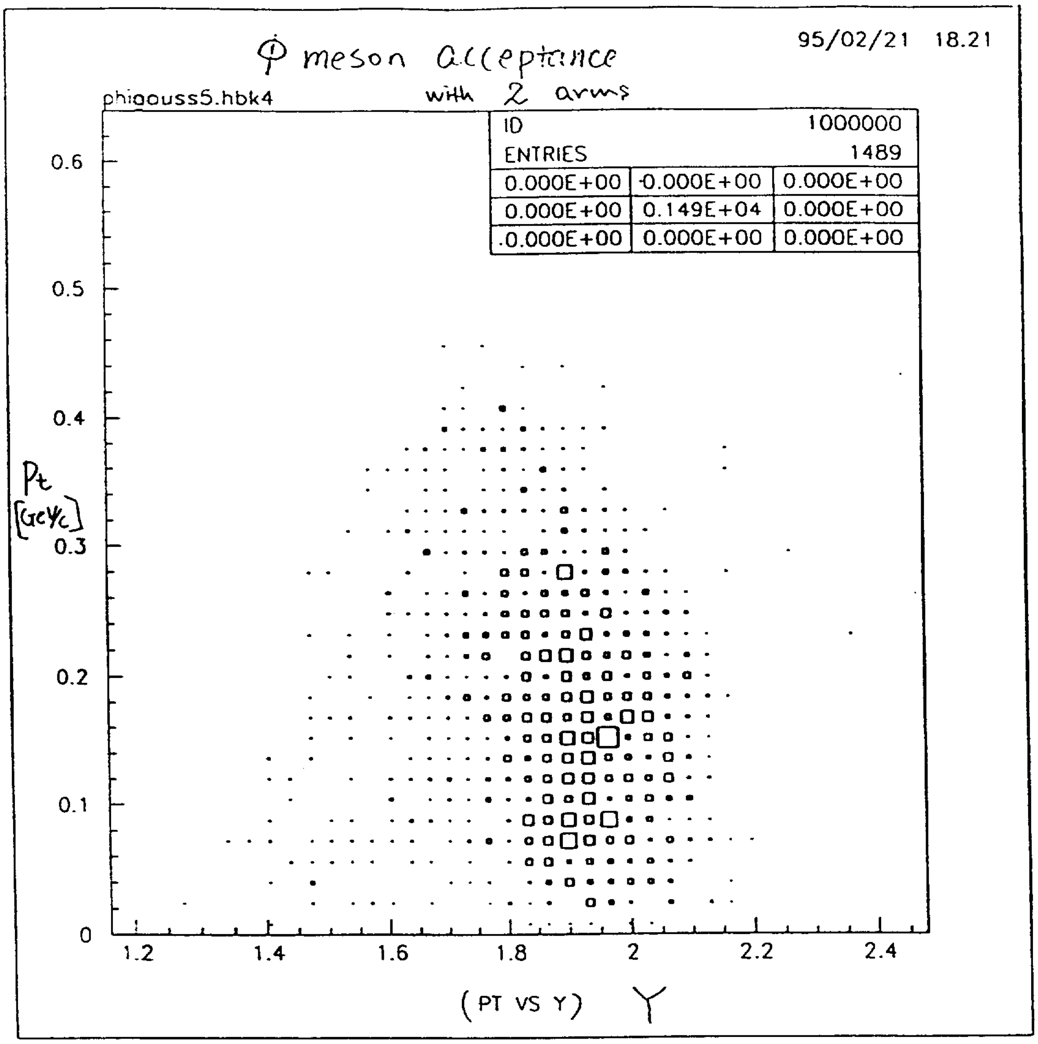

Fig.10 a) Acceptance for φ mesons

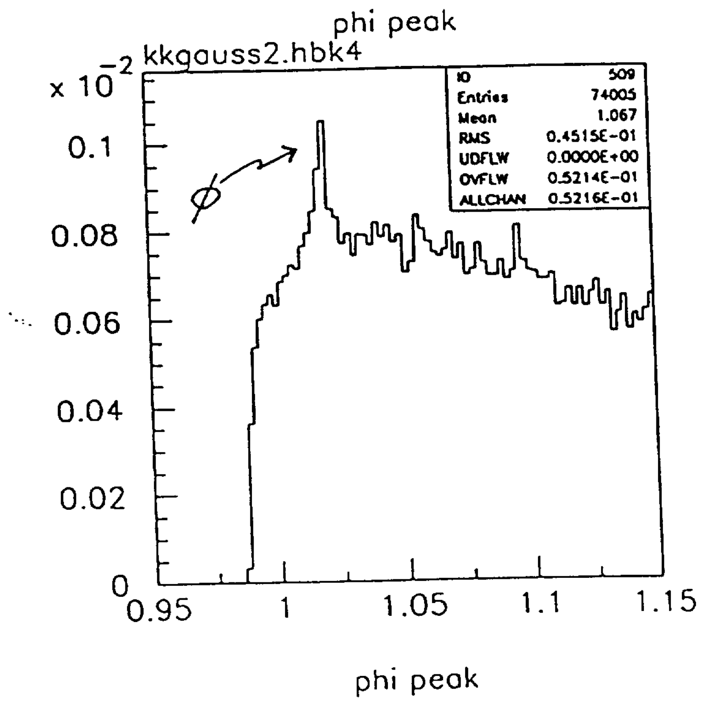

Fig.10 b) $m_{K^+K^-}$ invariant mass plot